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# AUTOMATION ORIENTED HEALTHCARE DELIVERY SYSTEM BASED ON MEDICAL SCRIPTING LANGUAGE

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FIELD OF THE INVENTION: AUTOMATION ORIENTED HEALTHCARE DELIVERY SYSTEM USING MEDICAL SCRIPTING LANGUAGE.

## Abstract

**This invention relates to automation of healthcare tasks delivered over a system installed on a local or wide area or network or intranet or internet computer network. This system and method is based on 1) a transportable human readable/machine parsable patient medical files or records coded in a medical scripting language with embeded executive commands for 2) a supervisory program with a transcendent medical belief system located at the server or client level, this supervisory program comprising means to interprete the medical scripting language and execute the embeded commands and 3)suitable patient file browsers ranging from standard Mosaic derived Internet browsers to a knowledge based medical spreadsheet ,to extend the spectrum of medical input and decision support in patient management to include all health workers and optionally the patient himself or herself.**

## BACKGROUND OF THE INVENTION

**Good health is the concern of any global citizen. Computerization has the potential to help automate many aspects of healthcare; among them being automated recalls and reminders, what-if clinical problem solving and collaborative singular patient problem solving by a plurality of healthcare workers sharing a standard patient file that is functional across any computer operating system platform. Automation of healthcare is impaired by the lack of a viable universal transportable medical record that can fully encapsulate the total patient experience of all medical events and ongoing treatment and management of a patient. Patient's needs include prescriptive recalls for periodic health checks or management tasks based on specific disease diagnostic and management protocols.**

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**In the internet era where knowledge is supposed to flow freely, modern medicine is incongruent in the sense that medical knowledge is packaged in a manner that is incomprehensible to most. The medical decision making based on scientific facts available to the practitioners is often a process that totally excludes the input of even the intelligent patient. This is in need of transformation. Modern medicine has often exalted the elitism of the medical profession and has in the main rejected or downgrades the possibility of the patient helping to diagnose and solve his own problems. This has at times progressed to the situation in some countries that any lack of patient fulfilment is translated to litigation. This has of course damaged the integrity of the medical profession where practice is now adapted to avoid litigation rather than providing best care. The cost of medical care is escalating in modern society for a number of reasons. Medicine has entered the phase of high technology with the proliferation of sophisticated laboratory and imaging tests with its attendant costs. With the plurality of service providers, it is economic from the healthcare budget and best in the patient interest to avoid duplication of tests. Also these medical tests should be done for the most optimal reasons.**

**Increasingly the goal of modern medicine is evidence based medicine/best practice where the management is strictly set out in protocols with time components. An example of such a protocol is that regarding the management of diabetes mellitus. Nowadays the current best practice for management of diabetes mellitus requires 1) initial referral to dietician and or diabetic educator 2) twice a year glycated hemoglobin (HbA1c) tests 3) annual review by opthamologist 4) yearly checks for microalbuminuria 5) yearly check by podiatrist 6) home glucometer checking.**

**With increased societal affluence and educational level, citizens expect the best and optimal care. These factors conspire to drive up health costs.**

**Aggravating the situation are 1) the existence of inefficiencies such as repeating unnecessary laboratory and imaging tests due to poor record keeping 2) drug to drug interactions 3) disease drug interactions 4)poor analysis of symptoms and signs from the viewpoint of insufficient physician time 5) restrictive work practice of the healthcare industry where the patient is locked out by an elitist medical profession: this often leads to a poorly informed patient 6) poor decision making that is tainted/driven by litigation**

avoidance 7) the lack of a collaborative framework wherby all healthcare workers and the patient can together pool their resources to help fix the patient's problems 8) The recent phenomenon of patient queries arising from medical knowledge gleamed from dredging the internet, this is a natural desire by intelligent and often internet savvy patients to "manage" their own medical conditions.

The doctor is challenged by the deluge of data generated by the practice of modern medicine; with the proliferation of tests and the need fortracking these tests, drug adverse reactions and interactions. There has been a veritable data explosion in the field of medicine associated with real advances in medicine.

To recapitulate, the health problems faced by the care of the citizen patient are:

1) patient's poor understanding of his own overall health problems, lack of knowledge tools to dissect his medical conditions.

2) patient's poor understanding and lack of access to reliable recordal means of the sequence of events such as laboratory and radiological tests relating to his health problems, inability to access his own record on the internet or computer network. In an ideal situation, the patient has the means to log on his internet browser to find out his latest lipids results.

3) patient is effectively disenfranchised from decision making based on scientific facts relating to his health problems from lack of an "independent machine expert" working on his medical status based on his medical record. Hitherto, there is no effective electronic transportable medical record framework for decision making.

4) Attendant risks due to poor medical record keeping arising from fragmented nature of medical care by multiple carers over time and geographical spread resulting in fractured medical records.

5) The lack of a write once, run anywhere computer medical record with built in embeded health protocol commands, regardless of computer platform. The absence of an effective transportable electronic medical record capable of fully representing patient status and ongoing management tasks based on concrete standards such as a text file of ASCII or even Latin-1 subset or UNICODE characters.

**6) Current art has medical records that are passive with data held in database fields, these data are aggregated/ searched/ processed and viewed by various data lenses. This passive structure of current electronic medical record design is contrasted with the need for patient records to include active executive commands, these set of commands would need to be individually tailored to each patient.**

**7)With prior art, the record keeping computer program analyses every record to see if a record qualifies for action to undertake preventive action / initiate medical action - for example an adult woman is to seek a periodic pap smear and a periodic mammogram, a man over the age of 40 to get his blood pressure checked every year. Whereas in the invention detailed later, the patient file has embeded commands individually tailored for each patient, these individual commands will each will launch its own protocol.**

**8)Poor coordination among a multitude of health providers. In an ideal situation, a health provider such as the family physician or specialist should be able to get an accurate run down on list of active problems, list of medications, lists of imaging and non-imaging test results and other related health information; this is to avoid the repetition of a test in ignorance of the fact that it was recently done. The ideal medical record must be able to provide "in a nutshell ability".**

**9) Current implementation of electronic medical records held in a network is plagued by privacy constraints. In this invention, the concept of headerless anonymous patient files written in medical scripting language is proposed as a way to obviate the problem.**

**10) Healthcare costs is aggravated by the time consuming nature of history taking and decision making. Significant cost savings can be derived if patient can present a list of properly defined and analysed symptoms during consultation with the doctor , a comprehensive medical history and management work sheet arrived at by the patient himself using the client spreadsheet browser, his file written in medical scripting language and interacting with the supervisory program detailed in this invention.**

**11) With present electronic medical record systems, the consumer is locked out of viewing and having a say about his medical data, and is a passive element in the healthcare process.**

12) A lack of a congruent set of patient data at the right palce and the right time. The pervasive internet fulfills the criteria of being online everywhere and every time as long as the network is up. The invention detailed below leverages on this fact and allows decisiveness at the moment of choice in healthcare.

The ideal healthcare system must empower the patient. In this internet age, the advance of educational level, the interest in health matters by consumers - there is potential for a win-win partnership between the patient and the collection of stakeholders in the delivery of healthcare. This invention discusses the framework and implemented steps that has to occur to bring this about.

## SUMMARY OF INVENTION

This invention relates to automation of healthcare tasks delivered over a system installed on a local area network/wide area network/intranet/internet. This system and method is based on 1) a transportable human readable/machine parseable patient medical files/records coded in a medical scripting language with embeded executive commands, and comprising means for patient medical problem solving utilising knowledge spreadsheeting.
2) a supervisory program with a transcendent medical belief system located at the server or client level, this supervisory program comprising means to interprete and execute the medical scripting language and 3)suitable patient file browsers ranging from standard Mosaic derived Internet browsers to a knowledge based medical spreadsheet to extend the spectrum of medical input and decision support in patient management to include all health workers and optionally the patient himself or herself.
This machine augmented healthcare delivery system obviates the above stated problems in healthcare based on the just enumerated three components.

A description of the three components follows:

1) The medical scripting language is used to represent the patient file or record . The terms “patient file” and “patient record” are used interchangeably in this document. A patient file may be stored as a computer text file or held as a very long string of characters in a single or more fields in a database system. Alternatively, a logical equivalent of a patient file is a persistent programming object. A

**patient file written in medical scripting language integrates patient care by its means to represent every tiny medical event that has happened to the patient. This file written in medical scripting language is human readable, this implies the power of expressivity describing medical conditions that can approach the flexibility of natural language processing. Because medical scripting language is constructed like a high level computer language, the patient medical file in this invention can be interpreted or compiled by a computer program. The structure of medical scripting language is defined in Extended Backus Naur Format, this same EBNF format is used to express high level computer languages such as Modula ( Programmig in Modula-2 by Niklaus Wirth , spronger Verlag 1982 ) and Smalltalk ( Smalltalk V , Digitalk corporation 1992). Medical scripting language is similar to say Java. Like any high level language, there are syntax rules and predefined keywords. The key difference between medical scripting language and say Java is that in Java there are approximately 48 keywords, whereas medical scripting language has in excess of twelve thousand keywords, with more to be defined. Each keyword in medical scripting language is a Docle expression. Docle is an alphabetic notational, coding and classification system used in clinical medicine. Medical scripting language is the glue that holds the disparate three components of the framework comprising the medical scripting language, the supervisory program and the patient browser together. The preferred future embodiment of this patient file is a computer file of the Unicode character set. The preferred current embodiment of this invention is with a subset of Unicode known as the ASCII character set, for the reason of compatibility with current keyboard design. The universally transportable medical record is coded in computer parsable, human readable medical scripting language and held as a string, based on the ASCII character set in this embodiment and possible future embodiments to include the complete unicode character set. This patient file structure may be a computer field, a computer record, or a computer file or a programming object. This patient file represents patient status and includes means for embeded executive commands for invoking the supervisory program to run the designated protocols to effect healthcare actions. In short, MSL or medical scripting language is task-oriented.**

**Representing a patient medical file in medical scripting language, and placing this file on a secured network ( or using the alternative option of headerless patient file in public networks ) such as the**

**internet, opens all the health data pertaining to any individual patient for access, to the multiplicity of health workers, and optionally the patient himself.**
**Representing the patient data in medical scripting language opens up the possibility of collaborative problem solving by the team of healthcare workers and could comprise the patient himself.**
**Medical scripting language allows the inclusion of commands (with programming arguments) that will launch protocols that will effect health actions such as a reminder by email.**
**Medical scripting language structures the patient file into sections that views the medical record as collection of time stamped 1)administrative 2)commands 3)actions 4)Presentation-not yet defined data 5)Links- about to be defined data 6)Unity- well defined data and 7)management data. This scheme is a prerequisite and foundational for use of the patient medical file with a patient browser termed a medical spreadsheet or knowledge spreadsheet where the data have to be allocated to a plurality of cells.**
**Medical scripting language allows the comprehensive coding and mapping of all medical entities held in the patient file, these allows for the decision support processing needed. In the preffered embodiment the patient medical scripting language file, the events are further tagged as negative, neutral, active or inactive. A summary abstract of his medical data comprising all global active medical events, global inactive events is a powerful enabling tool for the physician at any point in the globe to quickly evaluate a patient's general medical condition.**

**2) The supervisory program has a built in transcendent medical belief system. Transcendant in the sense that the Docle coding and classification system codes for all medical objects and objects of all medical thought. The supervisory program can be located at the server or in special cases at the client level. This supervisory program comprises means to interprete and execute the patient file written in medical scripting language. Protocols or tasks are invoked by embeded commands held in the patient file. All patients are different, they require individually tailored protocols relating to their conditions. Only a diabetic patient requires a protocol to prompt for six monthly glycated hemoglobin tests. It is the role of the supervisory program to launch each protocol as nominated by the commands listed in the patient file. It is the role of the supervisory program to launch a drug-drug or disease drug interaction protocols each time the patient file is updated.**

**The supervisory program has built in protocols to act in the event of oversight to detect these drug-drug interactions and disease-drug interactions. The supervisory program has a built in medical belief system and can respond to enquiries from client browsers using a knowledge spreadsheet tool to effect what-if analyses. The supervisory program can respond to an internet client request with a patient file coded in HTML format to enable reading of the patient file using a standard internet Mosaic browser such as Netscape or Internet Explorer. Alternately the HTML document can be configured to include tables, picklist, buttons and controls to enable the web client to have a spreadsheet application on his web browser. Other embodiments of this framework has the web client running this medical spreadsheet application using Distributed Smalltalk, Java, JavaScript, Java Beans, Active-X,VB Script or any newer method of implementing client Server Web applications.**

**3) The client patient file browser.**
**A variety of browsers ranging from stock internet browsers to specialised medical knowledge spreadsheet to view the patient file can be used by healthcare personnel and the patient to interact with his patient file which represents the total database of his longitudinal health record.**
**Any standard internet Mosaic browser such as Netscape or Internet Explorer will be able to view the patient file as the supervisory program comprises means to package the patient ASCII text file into HTML format. The browser has a utility to convert a ptient file in HTML format into a text file stripped off the HTML tags. Either way such a patient file can be viewed with a text editor such as Microsoft notepad.**
**The specialised browser for this internet health system is a knowledge spreadsheet tool called a medical spreadsheet filed under the heading " Iterative problem solving technique " reference : PCT/AU97/00362 .**
**The medical spreadsheet tool operates on the patient file encoded in medical scripting language. This spreadsheet tool is the preferred way for updating and interacting with the patient file.**

**This invention uses the framework of the computer network in all its present and future embodiments can and will transform the art and science of medicine into a stable and viable system of quality medical care that is affordable and technically easy for citizens to adopt.**

In the preferred embodiment, the system is internet based. The patient files are held in an internet server with adequate firewall to ward off unwelcome instrusions. The supervisory program makes a daily mark and sweep of all the patient files such that every single patient file is interpreted and any embeded commands executed. The result of such an execution of a command may result in an email reminder being sent to the patient and this action is logged and also sent to the primary care physician and medical specialists.
Addressing the specific problems enumerated in the background section:
This system and method for machine augmentation of healthcare will enhance and empower the patient with ready access to his medical record, such as to track his tests, and ability to manipulate it with a knowledge spreadsheet. The invention proposes a transportable electronic patient suitable for a framework of problem solving and automatic triggering of health actions. The network oriented nature of the system comprises means for access across the globe. The patient file is a string of characters based on the ASCII/ unicode standard, hence it should run on any platform. The patient file in medical scripting language is an active entity as it contains individually tailored prescriptive commands to invoke protocols in the supervisory program. The patient file held in a central server is the answer to duplication of tests. The headless patient files concept is one way to ameliorate the problem of privacy. The time consuming nature of medical analysis of symptoms/signs and clinical thinking can have its cycle shortened by the patient doing his homework on the medical spreadsheet and presenting to his clinician a more clearly defined reason for consultation - saving immense time. With optional patient access to his electronic file, integrity of his medical file is enhanced. The pervasiveness of his medical file in the intranet/internet embodiment allows integrity of decision making.

B) Description of the Supervisory Program

The supervisory pprogram comprises three components
1) the Medical Scripting Language Interpreter and
2) the protocol method
3) the PLUM medical belief system and query language system

1)The interpreter for the medical scripting language

**The interpreter builds up a virtual image of the patient by the use of dynamic data structures called OrderedCollections. These OrderedCollections are named according to the categories of medical data of a) Administrative b) Commands c) Actions d) Presentation e) Links f) Unity g) Management. The virtual image of the patient is constructed by populating these orderedCollections with events held in the patient file coded in medical scripting language.**
**Before the interpreter can execute the embeded commands held in the patient file, the patient virtual image needs to be build up first. The interpreter constructs the virtual patient image represented in the patient file by iterating through the following cycles.**

**The state of the interpreter**
**1) CurrentPatientName is a variable that holds the unique identifier to the patient file.**
**2) EventMode is a variable that sets the indicator to direct where each event is to be placed in one of the orderedCollections of events.**
**2) The named orderedCollections of a) Administrative**
**b) Commands**
**c) Actions**
**d) Presentation**
**e) Links**
**f Unity**
**g) Management**

**1) locate the patient file**
**2) open file or record**
**3) while not at end, read next line comprising string of characters up to "\\\" token**
**4) if at end of file, then close file and exit interpreter for now.**
**5) Evaluate if change in the event mode. If so go back to 3.**
**6) Add event to orderedCollection set by EventMode.**

**Having build up the virtual patient image, the interpreter now invokes the protocols as requested in the Commands OrderedCollection.**

**2) THE PROTOCOL METHOD**
**The protocol method is implemented to signal to the patient or health worker the need to take a decisive health action such as**

**having the blood pressure checked, a pap smear, a cholesterol test. The protocol parameters are 1) date when protocol command 2) periodic interval of preventive recall inserted 3) date of last action fulfilling action specified in protocol 4) date of last supervisory program recalling action such as email or mail out.**

**In the Smalltalk embodiment of the program, all the protocols held inside the patient file is executed by the following program instruction:**

**Commands do: [:x | self protocol:x ]**

**Where Commands is the orderedCollection of command events. x is a local variable that instantiates to the value of each event as the do loop iterates through each element of the Command orderedCollection.**

**The protocol:commandString method**
**A typical commandString is :**
**12 Aug 1998 command@preventiveCare@diabetesMellitus%%365%30**

**The variables and their role are:**
**topic = the preventive recall activity**
**activityPeriodicity = how often this preventive needs to happen**
**repeatRecallFactor = how often the program needs to nag patient/doctor**
**transpiredDaysActivity = number of days transpired since last preventive action**
**transpiredDaysNotify = number of days transpired since last patient notification**
**today := today's date**
**lastNotify := date last notified**

**The method uses the variables and determine their values as**
**1) topic := preventiveCare@diabetesMellitus**
**2) activityPeriod := 365**
**3) repeatRecallFactor := 30**
**4) activityPeriodicity = 36500 ? If true then quit protocol.**
**5) transpiredDaysActivity := today - date last preventive event in Management.**
**6) transpiredDaysActivity GREATER THAN activityPeriodicity?**
**7) If true then calculate lastNotify :=**
**last action@ preventiveCare@diabetesMellitus in Actions .**
**8) CALCULATE transpiredDaysNotify = today - lastNotify.**

9) transpiredDaysNotify GREATER THAN repeatRecallFactor? ifTrue then email patient regarding need to see doctor regarding preventive action concerning diabetes mellitus.

Extension of protocol method to include non health related matters such as birthday and other anniversary reminders and any reminders asscociated with social or business activities. Examples of useful reminders over internet email are i)Reminder to apply for a new passport one month before the expiry of one's passport. ii)Reminder to service the gas heater every three years. iii)Reminder to book a popular bayside holiday house in march for the Christmas holidays otherwise all accomodation would have been fully booked. This reminder system transcends the limitation of the constraint of a single year manual diary system.

An example of a non-medical reminder is:
12 Aug 1998 command@exceptionReport%'update your passport'%365%14

The above reminder is for an example of a situation where the passport expires at the end of September 1999. This command will trigger an email to remind the patient/person to update his passport on the 12Aug 1999 and will do so at a frequency of forthnightly until the command is fulfilled by an equivalent action event:

action@exceptionReport%'update your passport'

Alternatively the command can be deleted when the event ha sbeen fulfilled.

Technical Description of Medical Scripting Language Syntax

The Syntax of the Medical Scripting Language is expressed in EBNF.
This formal definition is based on Extended Backus Naur Formalism ( EBNF is discussed in Programming in Modula 2 by Niklaus Wirth).
EBNF Syntax rules are defined as:
Syntax = { rule }
rule = identifier "=" expression ".".
expression = term { "|" term }.
term = factor { factor }.

**factor = identifier | string | "(" expression ")" | "[" expression "]" |
"{" expression "}".**

**MSL is a sequence of syntax rules.**
**The right hand of each rule defines syntax based on previous rules and terminal symbols.**
**Parentheses such as ( ) group alternate terms.**
**The vertical bar | separates alternate terms.**
**Square brackets [ ] denote optional expressions.**
**Braces { } denote expressions that may occurs zero or more times.**
**A String is a sequence of characters enclosed in single or double quotes.**
**An identifier is a sequence of letters or digits beginning with a letter.**

**Example of a consultation defined in EBNF**

**presentation = 'cough' | 'fever' | 'jaundice' | 'abdominal pain' .**
**links = 'chest x ray abnormal'| 'ST elevation' | 'blood test abnormal'.**
**unity = 'pneumonia'| 'cold' | 'heart attack'**
**management = 'reassurance'| 'penicillin' | 'bed rest'| 'linctus'| 'patient education'.**
**consultation = presentation [ links] unity ( 'reassurance' | 'patient education') management .**

**An example of a consultation defined by above rules is**
**cough fever**
**chest x ray abnormal**
**pneumonia**
**reassurance**
**penicillin**

**Medical Scripting Language Syntax in EBNF**

**MSL_file = header "\\\" { ("\\\" keywordToCollection "\\\" {event "\\\" }) } "\\\"**
**header = "docle_msl%" string**
**"id%" string**
**"date%" date [ time ] [ "GMT" ]**
**"server%" string**
**"content%" text | html**
**"contentLength%" digits**
**"lastModified%" date [ time ] [ "GMT" ]**

**keywordToCollection = " #administrative " | "#command" | "#action" | "#presentation" | " #links" | "#unity" | "#management" .**
**event = date [ time ] docleExpression [ code%string ] [ imageLink ] comment [ accessionDetails ] [status] "\\\"**
**date = dd mm yyyy .**
**dd = 01 .. 31**
**mm = "jan" | "Jan" | "feb" | "Feb" | "mar" | "Mar" | "apr" | "Apr" | "may" | "May" | "jun" | "Jun" | "jul" | "Jul" | "aug" | "Aug" | "sep" | "Sep" | "oct" | "Oct" | "nov" | "Nov" | "dec" | "Dec".**
**yyyy = digit digit digit digit.**
**digit = "0" | "1" | "2" | "3" | "4" | "5" | "6" | "7" | "8" | "9" .**
**time = digit digit ":" digit digit [":" digit digit ] ["gmt"].**
**comment = { string} {"\\" string}.**
**packedString = { character | "_" | "-" }.**
**string = { character | " " | "_" | "-" }.**
**status = ++ | + | | -**
**docleOperators = "!" | "<" | ">" | "%" | "@" | "#" | "$" | "%" | "^" | "&" | "*".**
**letter = capitalLetter | "a" | "b" | "c" | "d" | "e" | "f" | "g" | "h" | "I" | "j" | "k" | "l" | "m" | "n" | "o" | "p" | "q" | "r" | "s" | "t" | "u" | "v" | "w" | "x" | "y" | "z".**
**capitalLetter = "A" | "B" | "C" | "D" | "E" | "F" | "G" | "H" | "I" | "J" | "K" | "L" | "M" | "N" | "O" | "P" | "Q" | "R" | "S" | "T"| "U" | "V" | "W" | "X" | "Y" | "Z".**
**character = | letter | digit | docleOperator.**
**docleExpression = {character }.**
**docleExpressionValueAdded = docleExpression "%" ( docleExpression | packedString | "" string " ' " ).**
**imageLink = { http:www address | fileDirectory }.**
**code = "icd10" | "icd9" | "snomed" | "otherCodingScheme"**
**command = "command@" docleExpression "%"[ string ] "%" digits "%" digits**
**preventiveCode = "preventiveCare@" docleExpression**
**action = "action@" docleExpression [ ("%" "email" | "mail" | "phone" | "fax" ) ].**

## The Medical Scripting Language Environment

**There are currently defined seven special tags of the type keyToCollection:**

**#administrative**
**#command**
**#action**
**#presentation**
**#links**
**#unity**
**#management**

**These tags head up collections of events described by the keyToCollection tags.**
**The Patient file is comprised of events organised into these collections.**

**Events are classified into the following types:**

**1) adminstrative**
**- these events deal with the administrative/office aspect of healthcare. Examples are 'medicare' , 'street' , 'suburb', 'state', 'country', 'phone@home', email, 'phone@work', 'phone@mobile', 'dob', 'marital' , 'upDate' 'markers', 'archive' , 'preferredDoctor' 'pension' 'aka' 'surname' 'kin' 'workplace' 'sex' 'firstname' 'state' 'warning' 'comment' 'zip')**

**2) command**
**The commands are used to invoke the supervisory program to the automate the protocols for 1) preventive health action 2)immunization 3)regular periodic prescriptions and 4)any other periodic medical protocols. The outputs from the execution of these protocols result in recall messages such as in the form of emails, messages, a useful computer output or printed prescriptions to be issued. The command codes have the prefix 'command'.**
**command@preventiveCare@diabetesMellitus**
**command@preventiveCare@diabetesMellitus@consultation@specialist@eye**
**command@preventiveCare@diabetesMellitus@hemoGlobin@glycated**
**command@preventiveCare@diabetesMellitus@eyeCheck%%365%60 ( repeat letter factor )**
**command@preventiveCare@lung**
**command@preventiveCare@weight**
**command@preventiveCare@alcohol command@preventiveCare@osteoPorosis**
**command@preventiveCare@colon command@preventiveCare@hyperTension**
**command@immunisation@infl-uenza command@preventiveCare@cervix**
**command@preventiveCare@breast**

command@preventiveCare@cholesterol
command@immunisation@hepatitisB'
command@preventiveCare@exceptionReport%'abnormal lft'
command@preventiveCare@prostate
command@preventiveCare@skin
command@immunisation@tetanus
command@prescription%'digoxin(lanoxin),250mcg,1 24hi,100 rp2' %200%200

The command@prescription is a powerful command in the sense that it automates the regular periodic prescription writing of a patient's medications. The command would trigger the preprinting of prescription scripts so that these scripts may be picked up the patient subsequently.

3) action
Arising from the execution of the commands held in the MSL file, preventive actions such as generation of a reminder via letter or email, these actions are recorded as events, each of these events would carry a docle header with a word beginning with the word 'action'. For each command has two numeric arguments, the first argument denotes the ideal interval in terms of number of days that the periodic health action should be carried out. The second numeric argument denotes the number of days that are allowed to lapse before another reminder is sent.
The action type events are used to indicate to the protocol for preventive health action belonging to the supervisory program.

action@preventiveCare@diabetesMellitus
action@preventiveCare@diabetesMellitus@opthamologist
action@preventiveCare@diabetesMellitus@hemoGlobin@glycated
action@preventiveCare@lung
action@preventiveCare@weight
action@preventiveCare@alcohol
action@preventiveCare@osteoPorosis
action@preventiveCare@colon
action@preventiveCare@hyperTension
action@immunisation@infl-uenza
action@preventiveCare@cervix
action@preventiveCare@breast
action@preventiveCare@cholesterol
action@immunisation@hepatitisB
action@preventiveCare@exceptionReport
action@preventiveCare@prostate

action@preventiveCare@skin
action@immunisation@tetanus

## The system and method of recall

The system of recall used is based on the mirroring the events in the following three OrderedCollections: Command, Management and Action. An example is the need for five yearly tetanus injections as prophylaxis of tetanus. In this instance, a tetanus shot has been given and a system of recall in five years is being set sup.
The tetanus immunization shot leads to the following event being recorded in Management:
8 Sep 1998 immunisation@tetanus

This will clear all action@immunisation@tetanus events in Action.

The command event is:
8 Sep 1998 command@immunisation@tetanus%%1825%30

This command directive states that if the last immunisation@tetanus event is more than 5 years then action is to send off email reminder.

Say 5 years from 8 sep 1998, that is around 8 Aug 2003, the supervisory program will interprete and execute the command line and find that the last immunisation@tetanus event is more than 1825 days old, an email will be sent off and the act of sending this email is recorded as the event below:

8 Aug 2003 action@immunisation@tetanus.

Say for example patient failed to respond to email reminder and no immunisation@tetanus was recorded, a second email will be sent 30 days later.

It is possible to launch more drastic action if three identical consecutive action events pertaining to the same topic are ignored, such as triggering postal mail or being listed for personal phone contact.

4) presentation type events are symptoms and signs of medicine
5) links type events represent results both normal and abnormal arising from imaging and non-imaging investigations in medicine.
6) unity events are well defined diagnoses in medicine, with defined prognostication and treatment in medicine.

**7) management describe the procedure and process of care in medicine and comprise drug, surgical and paramedical treatment**

**The event encapsulates the smallest quantum of information that may be significant in the process of healthcare of the patient.**
**The event is a string comprising the following subStrings tokens**
**1) The date token is of the format dd mmm yyyy**
**2) an optional time of day token hh:mm:ss and time zone.**
**3) a docle expression - e.g. diabetesMellitus**
**4) a comment string in single quotes.**
**5) an optional string held in square parentheses [ ] to denote date / author of event and electronic signature of person responsible for entering event.**
**6) the last token of the event, a flag to denote active/inactive/log/suppress status of event.**

**The operator % means has value, e.g. street%'121 borg st'**
**The single backslash \ is a docle operator that means 'decreased by'.**
**The double backslash \\ means a linefeed.**
**The triple backslash \\\ is used as a delimiter of section keywords and events.**
**The Docle coding system has over 14,000 docle expressions. Medical scripting language is like a programming language with 14,000 reserved words. Medical scripting language is unusual in the sense that it is both a programming and a data file. Because of this programming aspect of the medical scripting file, healthcare actions can be initiated at the opportune moment to effect best patient outcome.**

**Privacy considerations is a big issue in medical informatics. The medical scripting language comprises means with implemented steps of;**

**have the patient file downloaded to a client in the network stripped off the administrative data or any obvious patient identifier, termed a headerless file, to ensure privacy of medical record;**

**the patient identifier of this headerless file is a dynamic randomly computer generated number sequence known to both client and server, that is relevant only for the duration of the client computer session.**

**Control of patient file size/ culling of events**

**Automatic culling of events or compressing of changes is set by marking the status of an event as 'negative'. This is by using the - status flag just before the \\\ terminator for the event.**
**Action events that are over 2 years old may be deemed negative and transfer to archival storage to prevent overgrowth of patient file.**
**Archiving and compaction of files are executed by the embeded command to cull the events:**

**command@cull%%180%**

**Like all commands, there are three arguments. The first argument is null, the second argument is 180 which means that the compaction is done half yearly. The third argument is null as there is no need to inform the patient that his file is being compacted. The supervisory program will delete all events that are termed 'negative' i.e. has a - marker just before the end of event marker \\\.**

**Another useful command is to mark as negative those events that are prepared for culling:**

**command@negate@actions%%180%735**

**This above command will add a - sign at the end of each Action event that is 2 years old. This command will be executed every 180 days.**

**In one sense, the patient is like an actor, the physician is the director of the film script. The patient has to put on the 'patient role' as he undergoes surgery, being experimented on with drugs, taking tests, being filmed in the radiology lab. The SCRIPT is the main thing otherwise the patient and the physician will all lose the plot. The doctor keeps adding / amending the script when things turn awry. But the script keeps a fair record of what the actor (patient) and the director (the doctor) ought to be doing.**

**The key to orderedCollection tags are not necessary as the events headers (docle expressions) are already classified in the Docle medical belief system. Hence events can be reaggregated or merged. This redundancy provides safety for reconstruction of a medical record, repair of broken files, re -integration of files from a multitude of sources.**

**The medical scripting file is in ASCII Text format. The supervisory program can download to the client in plain text or in HTML format.**

**Headerless MSL file is a strong method to confer security of privacy to patients. Headerless patient medical scripting language file is one where the events belonging to administration are suppressed. That way the medical events can be made public without prejudicing the privacy of the patient.**

**SAMPLE MSL LISTING 29 aug 1998**

```
docle_msl%1.0
id%97649788
date%'27 aug 1998 09:03:07 GMT'
server%docle.com.au
content%text
contentLength%1240
lastModified%'5 jan 1998 19:08:17 GMT'\\\
\\\ #administrative \\\
18 jan 1998 medicare%'234567899' \\\
18 jan 1998 firstname%'David' \\\
18 jan 1998 surname%'Oon' \\\
18 jan 1998 street%'29 Darryl Street' \\\
18 jan 1998 suburb%'Scoresby' \\\
18 jan 1998 state%'Victoria' \\\
18 jan 1998 zip%'3179' \\\
18 jan 1998 country %'Australia' \\\
18 jan 1998 phone@home%'97638935'\\\
18 jan 1998 phone@work%'97638411'\\\
18 jan 1998 phone@mobile%'04109887'\\\
18 jan 1998 email%'docle@compuserve.com' \\\
18 jan 1998 email@second%'oon@connect.com.au' \\\
18 jan 1998 dob%'18 jul 1953' \\\
18 jan 1998  marital%'married' \\\
18 jan 1998  preferredDoctor%'Dr Y K Oon' \\\
18 jan 1998 aka%'Bav' \\\
18 jan 1998 kin%'Juliet  Kuang' \\\
18 jan 1998 workplace%'Stillpoint Medical ' \\\
18 jan 1998 sex%'male' \\\
18 jan 1998 comment%' golfer bongo player' \\\
18 jan 1998 warning%' ' \\\
```

\\\ #command \\\

18 jan 1998 command@preventiveCare@diabetesMellitus%365%30 \\\
18 jan 1998
command@preventiveCare@diabetesMellitus@consultation@specialist@eye%365%60 \\\
18 jan 1998
command@preventiveCare@diabetesMellitus@hemoGlobin@glycated%180%30 \\\
18 jan 1998
command@preventiveCare@diabetesMellitus@eyeCheck%365%60 \\\

18 jan 1998 command@preventiveCare@lung%365%30 \\\
18 jan 1998 command@preventiveCare@weight%365%30 \\\
18 jan 1998 command@preventiveCare@alcohol%365%30 \\\
18 jan 1998 command@preventiveCare@osteoPorosis%365%30 \\\
18 jan 1998 command@preventiveCare@colon%730%30 \\\
18 jan 1998 command@preventiveCare@hyperTension%365%30 \\\
18 jan 1998 command@immunisation@infl-uenza%365%30 \\\
18 jan 1998 command@preventiveCare@cervix%36500%0 \\\
18 jan 1998 command@preventiveCare@breast%36500%0 \\\
18 jan 1998command@preventiveCare@cholesterol%365%30 \\\
18 jan 1998 command@immunisation@hepatitisB%1835%30 \\\
18 jan 1998 command@exceptionReport%'abnormal lft'%60%7 \\\
18 jan 1998 command@preventiveCare@prostate%365%30 \\\
18 jan 1998 command@preventiveCare@skin%365%30 \\\
18 jan 1998 command@immunisation@tetanus%1835%30 \\\
18 jan 1998 command@ preventiveCare@warfarin%30%7 \\\

#action
27 aug 1998 action@command@preventiveCare@diabetesMellitus%email \\\
27 aug 1998
action@command@preventiveCare@diabetesMellitus@consultation@specialist@eye%email \\\
27 aug 1998
action@command@preventiveCare@diabetesMellitus@hemoGlobin@glycated%email \\\
27 aug 1998
action@command@preventiveCare@diabetesMellitus@eyeCheck%email \\\

27 aug 1998 action@preventiveCare@lung%email \\\
27 aug 1998 action@preventiveCare@weight%mail \\\
27 aug 1998 action@preventiveCare@alcohol%email \\\

27 aug 1998 action@preventiveCare@colon%email \\\
27 aug 1998 action@preventiveCare@hyperTension%email \\\
27 aug 1998 action@immunisation@infl-uenza%email \\\

1 may 98 action@preventiveCare@cholesterol%email \\\
27 aug 1998 action@immunisation@hepatitisB%email \\\
27 aug 1998 action@preventiveCare@exceptionReport%mail \\\
27 aug 1998 action@preventiveCare@prostate%email \\\

27 aug 1998 action@immunisation@tetanus%email \\\

\\\ #presentation \\\
2 jan 1998 nose@discharge \\\
2 jan 1998 cough \\\
2 feb 1998 head@pain 6 hrs \\\
7 May 1998 sleep@difficultyGoingTo ++ \\\
7 May 1998 nausea \\\
7 May 1998 diarrhea ++ \\\
7 May 1998 nausea \\\
7 May 1998 sleep@difficultyGoingTo ++ \\\
7 May 1998 diarrhea ++ \\\
27 Jul 1998 tiredness ++ \\\
27 Jul 1998 weight@loss 5 weeks ++ \\\
27 Jul 1998 appe-tite*l ++ \\\
27 Jul 1998 skin@pigmentation*h ++ \\\

\\\ #links \\\
27 Jul 1998 s@ferritin*l \\\
27 Jul 1998 s@glucose=%5.6 ++ \\\
27 Jul 1998 fullBloodExamination= \\\
27 Jul 1998 s@sodium*l ++ \\\

\\\ #unity \\\
2 jan 1998 upperRespiratoryTractInfection \\\
2 feb 1998 migraine \\\
7 May 1998 insomnia \\\
27 Jul 1998 hypo@natremia \\\

\\\ #management \\\
1 jul 1997 preventiveCare@hyperTension 120/80 \\\
2 jan 1998 amoxycillin@clavulanicAcid \\\
2 jan 1998 preventiveCare@hyperTension 120/80 \\\

2 feb 1998 meto-clopramide \\\
7 May 1998 preventiveCare@exceptionReport psa*h%8 \\\
27 Jul 1998 s@glucose \\\
27 Jul 1998 fullBloodExamination \\\ \\\

## THE MEDICAL SPREADSHEET BROWSER

### Overview

The deluge of clinical data and the complexity of modern medicine creates stress all round. Unpleasant litigation can be a consequence of a system failure to track and evaluate the plethora of clinical events. Change and stress can be met by creativity in utilising machine intelligence, but machine intelligence can only be expressed by having as its input a representation of patient status and a representation of management protocols specific to the patient.

In this embodiment, the medical consultation is modulated by a piece of software called the medical spreadsheet browser. It is an event oriented medical record system that keeps track of and evaluate the ever increasing number of patient clinical events arising from modern medical investigations and clinical contact.

The PLUM Medical Spreadsheet is a combination of the iterative problem solving method and a unique medical belief system built along the lines of the Linnean biological system and utilising multivalent logic. The construction of this medical belief system enables clinical expertise to be built up incrementally. The angle taken by the Plum medical spreadsheet is to use the spreadsheeting process as a recordal means during patient contact. Doctors can well, almost afford to forget all that they learnt in medical school! As at any stage of the consultation, a discrete query to the machine can be made. PLUM uses a plurality of data cells and the iterative problem solving method, characteristic of the spreadsheet. The name PLUM is an acronym for Presentation Links Unity and Management, which is the health model used in the medical spreadsheet.

The typical accounting spreadsheet is a number cruncher and gives the accountant quick answers to "What if?" type queries. The results of this "What if?" analysis are placed in the spreadsheet cells; this sets up the conditions for the next round of calculations with no manual transcription. The accountant's electronic spreadsheet is prodigious for tasks that require repetitive work with a hand held calculator. Hitherto, there is no such equivalent spreadsheet in either the medical or legal domains. With PLUM, during a client encounter, there is the capability of :

- allowing data entry and recording
- performing "What if?" calculations pertaining to client diagnosis and management, with the results placed in cells for the next round of evaluation and
- features such as scrollable worksheets which can be saved.

PLUM is used in a real or simulated patient or client encounter environment. During a patient encounter, the clinician needs to record the clinical details and constantly makes evaluations of clinical problems, resulting in treatment in the

event of a diagnosis. In the event that no diagnosis is made, further investigations are instigated. PLUM facilitates the recording of clinical data while at the same time using the same worksheet to provide computer evaluation of clinical status with resultant guidance regarding problem analysis, investigations and treatment. The motivation of PLUM is to introduce the spreadsheet metaphor into clinical medicine. There were at least two main barriers that needed to be surmounted to attain such an invention. The first was coming up with a replacement for the number system used in conventional spreadsheets. PLUM uses a word-based coding and medical belief system modelled on the Linnean classification. In this system a medical condition such as gout is a medical species with its own phylum, class, order, family and genus. Surmounting the second barrier was finding a suitable homogenous clinical data model of patient health status at the local encounter and the global level.

The traditional model of the encounter is called SOAP for Subjective (symptoms), Objective ( physical signs ), Assessment (what the doctor thinks of the whole consultation) and Plan of management. In the old medical model, the patient global status is a list of active/inactive problems. The homogenous model used by PLUM is the Graduated Discrete Definition Model which allows the clinical encounter data to be viewed in the same framework as the patient global status. This new model overcomes all the shortcomings of the traditional medical record where the encounter is disjointed from the patient global status. PLUM provides the clinician with a spreadsheet tool for use in patient care to effect efficient diagnosis, management and data recording. There is also a paper equivalent to the medical spreadsheet which forms the basis of an effective manual/hybrid medical record system. The input and output of the medical spreadsheet process are based on the cells of the spreadsheet during a real or virtual patient encounter. As the input and output arising from the patient evaluation are all cell based, this provides the powerful paradigm of iterative and hypothetical type problem solving. Applying the same spreadsheet metaphor, the pages (or worksheets) of this medical spreadsheet can be scrolled back and forth and get saved for future reference. This clinical data model used in the medical spreadsheet supports a logical framework for the recording of the clinical encounter and displays cumulative patient data in the same format as the clinical encounter. In this Graduated Discrete Definition Model, the classification of all clinical data uses one main criterion, which is the degree of definition of a clinical datum in terms of readiness for medical treatment and/or prognostication.

With such a classification framework, at one end of the scale there would be the not yet defined clinical data such as a clinical symptom or sign; these clinical data items do not have the degree of definition necessary for treatment or prognostication. At the other end of the spectrum, we have the well defined clinical data such as a diagnosis which has a clear prognosis and treatment. There can be one or more intermediate categories positioned between the not yet defined and the well defined categories. The preferred option of PLUM is an intermediate category called the about to be defined category. To complete this classification model, there is an additional category to include all extrinsic patient clinical data comprising treatment and investigations. The tetrad version of the Graduated Discrete Definition Model is called PLUM. All clinical data to describe the patient status and patient management is classified into the four categories of :

• Presentation - this comprises all not yet defined clinical data such as symptoms and signs
• Links - this comprises all about to be defined clinical data such as the abnormal test results and provisional diagnoses made by the doctor; these entities are not specific enough for treatment and/or prognosticati n but better defined as compared with the not yet defined data
• Unity - this comprises all well defined clinical data of the clear diagnosis type where there is specific treatment and/or prognostication
• Management - this comprises laboratory and radiological investigations, drug treatment, procedures and process of care.

PLUM represents the four categories of the tetrad version of the Graduated Discrete Definition Model. The clinical encounter form has four cells, representing the four categories of PLUM. The Presentation cell is reserved for not yet defined clinical data. The Links cell is reserved for about to be defined clinical data. The Unity cell is reserved for well defined clinical data. The Management cell is for clinical data related to treatment and investigations. The PLUM model provides the framework for the spreadsheet. The Graduated Discrete Definition Model, of which PLUM is the tetrad implementation, is congruent with the underlying logic of the doctoring process, which is the processing of unclear clinical information to resolution in the form of a well-defined diagnosis. This is followed up with treatment, or investigation if resolution is not possible. The "What-if?" query is launched from the drop down menu, of which there is a choice of over 50 useful types out of a possible 225 basic permutations. Typical queries of the medical spreadsheet would be:

•given symptoms and signs, show possible diagnoses
•given a set of possible diagnoses, symptoms, signs and laboratory test results, show only diagnoses that conform to available data
•given a list of diagnoses, show diagnosis that can unite several diagnoses.

After each computer-assisted evaluation, the worksheet is updated and the worksheet page number is incremented by one. The PLUM worksheet on the screen is called a page, it depicts a real or hypothetical image of the patient status and can be saved and recalled.
Another useful feature of PLUM is by clicking on the HOT KEY, this function evaluates all Presentation items, makes a list of differential diagnoses, from the list of differential diagnoses proposes a weighted list of symptoms and signs to ask/look for.

Docle Systems stumbled onto the PLUM Medical Spreadsheet almost by default. It is the originator of the Linnean Docle medical coding system used by over 5000 medical practitioners Australia-wide. It was the congruent classification of disease entities, akin to the building of a belief system framework that allowed the medical belief system to be viewed using the spreadsheet metaphor. PLUM is relevant to any problem domain where the problem s lver needs to arrive at a

diagnosis given a set of indeterminate data. The knowledge domain that almost mimics the medical domain is the legal field, and an equivalent theory for legal problem solving in the spreadsheet form also exists (patent pending). PLUM represents a new class of software - non-numerical spreadsheets.

**Technical Description of the Medical Spreadsheet Browser as a Web Application**

**To start the medical spreadsheet browser:**
**1. Start the web browser. This may be Mosaic, Netscape or Internet Explorer.**
**2. Using the web browser, request the following URL:**
**http://www.hostMachine/launch/plumSpreadsheet**
**3. The browser sends the request to the server hostMachine.**
**4. The hostMachine uses default resolvers, the path 'launch' will cause the execution of the program plumSpreadsheet on the host machine. In this embodiment, an instance of class plumSpreadsheet, a user interface session of the medical spreadsheet, is created. Sessions make possible for multiple users to have concurrent use of the server supervisory program.**
**5. The server will seek verification of user and password.**
**6. The patient file written in medical scripting language is retrieved.**
**7. The plumSpreadsheet session main menu will have choices for global log, global inactive or global active displays, an encounter spreadsheet form, save and cancel buttons.**
**8.Say the plumSpreadsheet encounter is chosen, session will then instead of splashing a screen with a plurality of cells on the screen and a pick list, converts the panes and text into a hypertext Markup Language (HTML) document which is despatched to the browser for display.**
**9) After entries are made in the Presentation, Links, Unity or Management panes, then if one of the queries is acivated then a submit request and the data in the spreadsheet in the cells is then despatched from the client browser to the supervisory program.**
**10) The supervisory program evaluates the spreadsheet query, produces an appropriate response and then despatch the answer back in HTML format to the client.**
**11) Go to 9.**

**The Docle coding classification and medical belief system.**

Any medical decision support system, from the most rudimentary to an encompassing system, requires a belief system comprising of a basic set of assumptions. Based on this premise, one cannot achieve a useful global decision support system encompassing the fields of medical history taking, physical examination, investigations, diagnoses, surgical treatment and drug therapy - unless a general medical belief system is constructed that spans across all the domains mentioned. This presentation describes a coding, classification and general medical belief system that spans and embraces two separately defined fields of endeavour in medical informatics today. On one end of the spectrum, there is the field of endeavour relating to medical coding and standardisation of terminology. To the other end of the spectrum, the field of endeavour is the construction of medical decision support systems utilising IF-

THEN rules or similar AI techniques. The schism between coding and knowledge representation has resulted in a situation akin to the architect using drawings to represent his designs while the builder is using a text description to build the house. The alphabetic Docle system unifies coding, classification and knowledge representation. Docle is different, the coding part being the mere keys to the medical belief system. Medical entities are classified as species and placed in a Linnean hierarchy much like a species such as Homo Sapiens. For instance, the liver object at the level called ORDER, knows all its associated diseases, symptoms and signs. So what is the big deal? A coding cum classification cum medical belief system appears to be an efficient approach for the construction of decision support computer programs - and may well save years of hack work for the implementor.

The coding system for medical data is the "glue" that makes health informatics happens, without this proper "glue", projects will fall apart. Hitherto numeric coding systems such as ICPC and ICD are designed for epidemiologists and statisticians. The next wave in medical informatics is to encode medical data for day to day patient care, clinical decision support, transportable medical records and intelligent medical systems. These next wave projects have severely strained the old numeric coding paradigm. Next wave coding schemes will likely to be alphabetic and will incorporate attributes of medical belief systems. A code for a symptom will be linked to associated organs. The Docle coding system is used by more than 2000 medical practitioners in Australia, making it the most used coding system in general practice in Australia today. The classification system comprises the following phyla or chapters: disease diagnoses, symptoms, signs, reasons for encounter, diagnostic imaging, diagnostic non-imaging, treatment procedures, and therapeutics. The Docle coding and classification system has been designed to solve the following problems 1) a coding system in medical informatics 2) a method to achieve standardization of medical abbreviations 3) a medical belief system that parallels the Linnean model in biology suitable for the organization of medical knowledge and 4) a medical belief system suitable for the design and implementation of sophisticated medical decision support systems. The Docle health classification system has drawn the two strands of biology and medicine together in that they follow the Linnean model of classification.

## How is Docle different from today's numeric coding system?

### 1) Variable versus computer constants

One of the biggest differences between Docle and the prior art of Read, ICD, SNOMED and ICPC is that Docle uses the computer variable concept while the rest of the field are implemented like computer constants. A variable is like a container. This container in Docle, called a Docle object, can be accessed via primary, secondary and tertiary keys. The three types of keys are equivalent in the sense that they all point to the same container with its stored methods and data. Inside the container is the 'belief system' about the object. While the name of the variable is fixed, the contents of the variable may vary over time. The variable may contain a pointer to another variable and ad infinitum. The variable defined may be a huge data structure, itself may hold assorted variables and constants. Such a dynamic design gives maximum flexibility to cope with changes. As opposed to this framework, one can use the old method of say item 222 maps to diabetes mellitus or a slight modification such as LK222 where L implies it is a symptom and K implies cardiovascular. Any

classification based on symbolic constants will suffer the ravages of atherosclerosis. Docle makes use of the concept of separation of the belief system data from the key code itself. This deferment of data binding to the code key provides Docle with unparalleled flexibility to expand and mutate with the growth of medical knowledge. The key, be it primary, secondary or tertiary (see later) - all leads to the same medical object with its stored behaviour. Medical advance will lead to gradual adjustments to the behaviour of the medical object. It is hard to envisage the need to change species names such as rheumatoidArthritis or diabetesMellitus.

**2) Number codes is not a viable belief system**

The Linnean System in biology is a viable belief system that is alive, moving on with the advancement of biological knowledge. It is a framework or road map to the realm of biology. The gaps in the Linnean framework excites the imagination of the biologist about missing links in their knowledge. It is a powerful method of cognating the knowledge that is being accumulated. This yearning for classifying and cognating medical knowledge was expressed in the preface of the ICD 9 manual, but it was just a yearning. Docle attempts to satisfy this yearning by tying the two strands of biology and medicine together. The docle classification system is modelled on the Linnean system, entities are described as medical species and medical genuses. Lists of numbers mapped to diseases are suitable for statistical analysis but will never excite the imagination of the medical researcher.

**3) Granularity problem and the Genus chunking solution.**

The granularity problem is familiar with anyone attempting to write a decision support program in medicine. An instance of this problem is the flagging of the disease/drug interaction between the beta-blockers and diabetes mellitus. It would be tedious, inefficient and prone to error to try to pick up every specific type of beta-blocker interacting with every variation of diabetes mellitus. An example of the beneficial effects of chunking into genus level is the case of diabetes mellitus. Chunking up of the three variants of diabetesMellitus: diabetesMellitus@gestation, diabetesMellitus@insulinIndependentDiabetesMellitus, diabetesMellitus@nonInsulinDependentDiabetesMellitus
into a genus called diabetesMellitus, allows the common behaviour to be stored in the diabetesMellitus genus object. Likewise we can chunk up the therapeutic species of propanolol, atenolol and metoprolol into the medical genus betaBlocker. An adverse drug-disease interaction is flagged when the two genuses of betaBlocker and diabetesMellitus are combined. A new beta-blocker will inherit this interaction behaviour as soon as it is tagged as belonging to the genus of betaBlocker in its container holding its belief system.

**4) Why choke on number codes when Docle is a feast in verse?**

Up till now, SNOMED and all the predominantly numeric coding systems based on the the multiaxial concept had looked promising. With SNOMED and all its derivatives, as much information as possible is loaded into the code. An example is SNOMED coding for pulmonary tuberculosis with granuloma being T-2800 M-44060 E-2001 F-03003. Another example of the relentless drive to pack as much information into its code as possible is the Read code, the code G3011 stands for acute anteroseptal myocardial infarction. The G denotes the cardiovascular axis, the 3 denotes ischaemic heart disease, the 0 denotes acute. The modern numeric codes such as Read and ICPC have been heavily influenced by the SNOMED technique of cramming as much information as possible in its code by using the multiaxial

technique. In practice such a scheme goes awry as a condition could be both cardiovascular and infective, such as viral myocarditis. Such a scheme leads to a fixation on the codes rather than concentrating attention on the evaluation of the state of knowledge of the disease entities. It is like, we have got a space here in our number scheme, let us see if we can fit in any more entities. By then adopting the classification in vogue for a subspecialty, it is locked in a concrete code format. It may be effective for several years but leads to incongruities in the future as technology advances. With such a system, five years down the track you wish you had added an extra axis to cater for the explosion in knowledge about the genome.

Another incongruity detected in the ICD9 coding system used in hospitals is the duplication of codes. Tuberculous meningitis can be viewed from the tuberculosis angle or the meningitis angle, hence there are two different numeric codes 013.0 and 320.4 describing the one and same entity. Such an incongruent event would not occur in Docle as the code/key for tuberculous meningitis leads to an object with inherited behaviour of tuberculosis and meningitis. The opportunity to save programming time in decision support construction is obvious. Instead of enumerating all the symptoms, signs and laboratory findings of tuberculous meningitis - one can cognate the belief systems of the tuberculosis and the meningitis objects, then overlay with the belief system data and methods unique only to tuberculosis meningitis. Docle is intuitive and suitable for a unified medical abbreviation standard, for example; *carc.thyr* means carcinoma located at thyroid. Currently there are 14,000 terms in the Docle dictionary, there are still 40,000 terms that are still unrecognisable in a feedback among the 100 respondents in the 2000 user group, these are mainly tertiary type keys which will be incorporated. Compared to the constant tinkering with the structure of Numeric systems, a word based system is comparatively stable and easy to maintain. The stability is derived from the fact that the docle term is a direct transcription of an entity that is real. The code diabm means diabetes mellitus, there is never a need to change codes. However the behaviour of the *diabm* object needs tinkering with the evolution of knowledge

**5)Code shear technology.**

Docle is built up of words joined by operators, much like an internet address. Coded entities are modified by aspects such as laterality, acute, chronic, simple, compound, complicated and male or female. The modifiers are added to the main code by clicking of buttons. The & character is the shear operator, an example is the code fracture.femur&rightHandSide&simple. During processing the substring &rightHandSide can be sheared off to return the basic code: fracture.femur .

**6) Best Practice by stealth**

Evidence based medicine, world best practice - that is the catchcry of modern day practice. For the sake of efficiency and wanting to conform to world's best practice, under Docle, best practice can be encoded inside the Docle object, each disease docle object can have a list of ranked recommended treaments and a list of ranked investigations. All these rapidly changing knowledge updated on the clinician desktop every three months. Adoption of a Docle type coding system will achieve Cochrane by stealth.

**Overview of the Docle Linnean Classification System**

The metamorphosis of Docle from a nomenclature to a classification system has been a slow evolution. The problem had been the false belief that diseases were properly classified by the ICD group under WHO auspices. While subspecialties have done

neat jobs in their little domains, there is no grand framework to tie things together. Classification was initially deemed outside the problem domain that Docle was designed to solve.. Yet medical informatics has hit the wall with the lack of an efficient coding system, or as is generally thought. Is it a coding problem that we have? No one talks of assigning number codes to species of plants or animals. There does not appear to be a coding problem in biology.

Then came the overwhelming realisation, that maybe it is not merely a coding problem. The "medical coding problem" has not been properly defined, hence the sometimes heroic solutions end up as astronomical flops. The problem is more profound than that. The problem is that a mature classification of diseases and related medical entities does not exist. Not one exists, as well developed and as disciplined as the biological classification system. We have failed miserably not coming up with a set of species names for disease entities. We have failed to define the concept of a medical species. There are no medical equivalents for the phylum, class, order, family and genus. There is no equivalent binomial nomenclature in Latin for rheumatoid arthritis or myocardial infarction. So instead of insisting on a genuine standard, like what the biologist got with his Latin binomial nomenclature, the medical fraternity has sold out for several long lists of number codes. These purport to cover a complete list of diseases, whose links to reality become tenuous with the passage of time. The lack of emphasis on species identification, and the attendant lack of standardisation of species names is of course due to the absence of a congruous framework. The rapid development of medical science and the critical lack of a decent classification framework for the medical field has resulted in a fragmented state of affairs. We have islands of information coded variously in SNOMED, ICD, Casemix/DRGs and ICPC. UMLS identified the problem, but instead became subsumed by it.

Instead of coming up with more sets of numbers linked to medical entities, the challenge is to create an equivalent Linnean system. The proposed Docle framework is a classification system for the medical domain based on the Linnean model. We are not yet proposing Latin binomial nomenclature. It is unlikely the medical community will stomach the wholesale renaming of medical terms in Latin, not that it works. Classification by the direct transposition of the medical domain into the biological model of course does not work as the framework is not fully compatible. For that to happen, there are three prerequisites. Firstly we need the equivalent of the binomial nomenclature. This nomenclature must be a powerful and standard way of describing medical entities. Secondly, we need to completely rework the Linnean hierarchical levels and introduce new definitions for the various levels. Thirdly, we need to create new rules for the classification process. Instead of Latin names, we have a structured medical descriptive language called Docle. In the majority of cases, Docle names are names of medical entities that are straight out of the medical textbooks. Occasionally they may look like someone's internet addresses. These peculiar names are Docle expressions, first presented at the 1987 RACGP computer conference in Melbourne and subsequently at theAPAMI94, HIC95, HIC96 conferences. The epiphany for Docle happened in 1995 when it metamorphosed into a Linnean framework. For a more detailed discussion - see book published in 1995 and the HIC96 conference proceedings.

The direction that Docle has taken is to use the concept of the species name as the KEY to a medical object, also called a Docle object. Hence Docle is a classification of medical objects. This classification of medica objects is also called Objects Medica. The medical object holds information that refers to memberships of

taxa, pointers to species in lower levels of hierarchy and its own level of hierarchy. That way as medical science progresses, the medical object is updated but the key remains stable. As there is no need to assign numbers to entities that are not numbers, species names are alphabetic. The problem is therefore straightforward 1) We have to identify all the species (or subspecies thereof) of medical objects 2) Assign to each species named, an object which is a data repository regarding its memberships of taxa and other information and 3) Classify them into a logical framework satisfying the requirements of all manner and types of health workers. This is important as previous coding systems were designed for the medical statisticians and certainly not for the information scientist who is developing applications such as a) for decision support in a clinical setting b) paperless medical records.

## The Docle Framework

Nothing could be more logical than to borrow some ideas from the impressive edifice of biological classification started by Linnaeus in the 1750s. One of the central tenets of biological classification is the concept of the species. The other tenets being the hierarchies and the concept of the taxon (plural taxa). A taxon is a group with shared values in each hierarchy. Species identification is half the work, while the other half involves placing the species in the right taxon in the right hierarchy.

The system of classification in Docle is based on the above framework with major modifications. It would be fair to say that Docle is the offspring of Linnean classification and the object oriented language Smalltalk. Whilst the concepts discussed were first implemented in a computer system in Smalltalk, there is no problem whatever for Docle to be a manual system or written up in any standard database or high level computer language.

The main deviations from the Linnean model are:-

1) There are more hierarchies defined below the species level. There are the subspecies, subsubspecies subsubsubspecies and subsubsubsubspecies levels already defined.
2) A species or any of its subclasses can have membership in any number of taxa at any level. This is the multiple inheritance feature of Docle.
3) The corollary of the above is that a species may have no membership of any taxon at any level.
4) As implemented in Docle, a taxon knows its membership. A species knows who its subspecies, subsubspecies, subsubsubspecies and subsubsubsubspecies are, if there is any.
5) The taxa at the next level down of the hierarchy does not need to be descendants of a taxon at the current level.
6) The entity to be classified is held in a Docle object (also referred to as medical object), the name of the object becomes the key to the object. There are three types of key to these Docle objects. The primary key is the complete key that can look like a textbook name or an expression that looks like an internet address. Example of a primary key is *diabetesMellitus*. Note the absence of a space between diabetes and

mellitus. The secondary key is computer generated and is an abbreviated version of the first using the Docle algorithm. Hence the secondary key is diabm. A secondary abbreviated key is useful in that doctors like to communicate in a shorthand manner when possible. It is also a subtle method to get doctors to standardise on abbreviations. The tertiary keys are the nominated aliases of the entity. To summarise, in the case of diabetes mellitus, the primary key is diabetesMellitus; the secondary key is *diabm* and the tertiary keys are the aliases: *diabetes, sugar diabetes.*
7) I have elected to use Americanised spelling. I am going to hear moans from the Commonwealth camps. Docle is about simplification, simplification and simplification. If it takes American spelling to make things simpler, we should simplify. Using American spellings add one more significant character to the Docle abbreviations.

**The hierarchies in Docle**

1.Kingdom - there is only one taxon located at this hierarchy.
It is named Objects Medica. Objects Medica holds all medical objects and all objects of medical thought.
2.Phylum - the taxa are:

a) Medical Administration
b) Symptoms Signs
c) Diagnostic Non Imaging
d) Diagnostic Imaging
e) Procedures Process Of Care
f) Therapeutics
g) TAMTAP- (Thinking About Medical Thinking And Practice)
h) Reason for encounter
I) Clinical Domains

3. Class - the taxa are the various clinical fields in medicine.
The groups are Adolescent Health, Blood, Cardiovascular etc.
4. Subclass - is reserved for the exciting frontier of genetic medicine. With the complete mapping of the human genome, gene locations/regions can be linked to specific medical syndromes. For example the HLA class II genes is linked to IDDM. We can use taxa such as a) X-linked b) Y-linked. We await a uniform nomenclature for gene maps.
5. Order - the taxa are named anatomical locations and organs.
6. Family - the taxa here are for the biochemical and physiological bases of disease. This can be at the molecular and cellular level. Examples of the groups here are a) Disorders of lipid metabolism b) Disorders of the prostaglandins
c) Disorders of nitrous oxide metabolism d) Disorders of heat regulation e) Disorders of the mucopolysaccharides f) Disorders of cell membrane transport. The subfamily hierarchy is reserved for taxa related to DRGs and Casemix.
7. Genus - a taxon at this level is a larger concept and holds from 11 to 200 species. Examples of taxa are a) valvular heart disease b) arrythmia c) fractures d) benign neoplasm e) malignant neoplasm f) intermediate neoplasm.
8. Superspecies - a taxon at this level is a concept that holds 2 to 10 species.
An example of a superspecies is fracture of the femur. It is not specific enough for treatment and prognostication, it contains several species.

9. Species - The root word is the Latin *specere* which means to look at. At the species level the medical entity is real and can be looked at or experienced by the patient/clinician. A species belonging to the phylum Clinical Domains is a characteristic syndrome with clinical features generally known. Often there is knowledge about its aetiology. There is knowledge regarding diagnosis by clinical and/or non-clinical methods. There exists in many cases a knowledge of its natural history. There is associated a system of management of this syndrome and in many cases methods of prevention. A diagnosis at the species level or better is required for specific therapy. Examples of a species are diabetesMellitus, fracture.femur@neck and acidosis@metabolic. Species belonging to phyla other than Clinical Domain are non-abstract entities such as cough, chest X ray, or a swelling located at neck.
10. subspecies - A differentiated type arising from species, it suggests more specific treatment and prognostication.
11. subsubspecies - A more differentiated type arising from subspecies. .
12. subsubsubspecies - A differentiated type arising from subsubspecies.
13. subsubsubsubspecies - A differentiated type arising from subsubsubspecies.
14. subsubsubsubsubspecies..........

**A case study - classification of fractures involving the neck of femur.**

The primary keys are followed by its secondary keys.
The production of these secondary keys are automated by the use of the Docle algorithm

| | |
|---|---|
| kingdom: | object medica |
| phyllum: | clinical domain |
| class: | musculoskeletal |
| order: | femur |
| family: | disorder of bone metabolism |
| genus: | fracture.femur - frac.femu, fracture - frac |
| species: | fracture.femur@neck - frac.femu@neck |
| subspecies: | fracture.femur@neck@pertrochanteric - frac.femu@neck@pert |
| subsubspecies: | fracture.femur@neck@pertrochanteric@avulsion - frac.femu@neck@pert@avul |

A Docle type solution to medical coding is inevitable if we use the evolution of computer languages as a paradigm. Computer programming moved from an instruction set of ones and zeroes to assembly language to high level languages and 4GL. Likewise medical coding will jump from mainly numeric to alphabetic expressions. Docle is human readable and is more suited to input validation. For instance the dot operator means "located at", validation routines will make sure that the referred site is a valid anatomical one. Docle is human readable, hence it is more suited for mission critical tasks because the nurses and doctors can visually vet for the correctness of computer data. The concept of Docle keeps evolving and with time it will be obvious to the keen observer that Docle is a more logical system. History,

logic and commonsense sometimes win in the long run. Technology cycles are fuelled by marginal increase in utility. The Docle codes are both human and machine readable, these codes are actually embedded in the case notes in the encounter form as implemented in the Event Oriented Medical Record (EOMR). The explosion of medical knowledge in the past twenty years has been phenomenal. There was no knowledge of HIV infection or the nitrous oxide mechanism in physiology back in 1975. It must be puzzling to the biologists that the medical sector needs so many coding systems - SNOMED, ICPC, Read and ICD etc. The existence of multiple coding schemes is a hint that a sweeping simplifying solution is called for. UMLS has not lived up to its promise for a simple reason. Two wrongs do not make a right. With the changing pattern of health care delivery and a highly networked society, the advantages of a unitary system like Docle that can span across the various departments and specialities would be obvious. The statisticians can work at the genus level. The primary provider at the species level, the specialists and research scientists can work lower down at the subspecies or subsubspecies level. By the application of a human readable, character based primary Docle code, which the resident medical officer enters from a pick list in the patient electronic record - that piece of data capture by the resident medical officer or the staff nurse meets the data requirements for i) the day to day patient recording ii) medical decision support and iii) administrative purposes.

A bit of trivia. All Docle objects are linked together to form a viable and congruous belief system. As an example of the congruity of the system, Docle has thrown up a previously unnamed body organ. Docle is fussy with its use of the dot operator and maps all body organs. It detected a gap in its anatomical hierarchy. The anatomical locations scrotum and testis has a missing superclass, Docle has christened this organ the tistum. The docle for tistum is tist which has as its subclasses scrotum and testis. In one sense, Docle is the first medical coding system with balls.

Conclusion

The coding wars may be over, even before the first shots are fired. While government and quasi-governmental bodies trash out the merits or otherwise of the various medical coding systems, the goal posts regarding the ideal medical coding system have along with the computing juggernaut, inexorably moved forward. The internet standard called Common Gateway Interface (CGI) was accepted as an international standard, but overnight it became dated as Java and ActiveX were launched. Number based medical coding systems will probably go the way of CGI due to the relentless pursuit of quality and utility. And why not?

Docle is a belief system modelled on the Linnean biological classification system. Medical entities are classified as species and placed in a hierarchy much like a species such as homo sapiens. Every one of the over ten thousand Docle medical objects are thus related in a congruous framework. For instance the liver object at the level called ORDER knows all its associated diseases, symptoms and signs.

The true tension in medical informatics is not a coding battle but it is a war of the electronic and intellectual representations of the current medical belief system. The Docle health classification system has drawn the two strands of biology and medicine together with the common Linnean model. The fundamental issue in medical coding and classification today is the same as the biological classification conundrum in the days of Carolus Linnaeus in the 1750s, the solution is to define (or in the case here revisit and annoint) the concept of the medical species, identify the said species and give them names. Then stick with the names until they are proven to be inaccurate. This will impart order in the medical informatics domain and may well save years of hack work for the medical software implementor.

## Claims

**1. A system and method for machine augmented healthcare delivery installed over a local, wide-area or internet network comprising 1) a supervisory program at the server, this program comprising components of medical belief system and interpreter for a medical scripting language for patient data representation; 2) a transportable patient medical file coded in a medical scripting language that is machine parsable and human readable; the patient file comprising means to represent patient status and means for embeded executive commands for the said supervisory program to effect healthcare actions; and 3) At the patient or healthcare worker client level, browsers ranging from a text based editor or standard Mosaic derived internet browsers, to a knowledge based medical spreadsheet that can be used to browse and operate on the patient file coded in medical scripting language.**

**1a The system and method of claim 1, comprises a medical belief system starting from a linnean classification of all medical species and subspecies, including steps of**

**classifying each species into phylum, class, order, family, family and species;**

**using a plurality of alphabetic keys to point to each medical object;**

**creating a plurality of alphabetic keys by using operators to join basic word building blocks to form complex expressions.**

**2. THE SUPERVISORY PROGRAM comprises implemented steps of:**

**mark and sweep on a periodic basis whereby every single patient file is processed at least once per sweep, the method comprising implemented computer steps of:**
**opening and parsing each patient file written in medical scripting language;**
**extracting all commands to be executed embeded in the patient file ;**
**storing all presentation or symptoms or signs events in a data collection;**
**storing all links or medical investigations result events in a data collection;**
**storing all unity or diagnosis events in a data collection;**
**storing all management or prescription or procedure events in a data collection;**
**launching all the commands operating on the stored patient events data;**
**comprising means to send off computer message to effect better healthcare of patient via email, voice mail, fax or print letter or using other communication modality to patient or/and healthcare workers.**

**2.a The method of claim 2, whereby the preferred embodiment is for the supervisory program to do a mark and sweep on a daily basis whereby every single file is processed at least once per day.**

**3.The transportable patient medical file written in medical scripting language comprising steps of:**
**declaring the medical scripting language in Extended Backus Naur Format;**
**representing the patient data file in a medical scripting language that is in human and computer readable format;**
**representing the patient data file in a medical scripting language that comprises passive data elements and programmable commands to create dynamic alerting/recall actions;**

representing the file as a character string with preferred embodiments in ASCII format or ISO Latin-1 subset of the unicode character set or unicode character set itself;

deconstructing and reconstructing patient data into a data structure called an event;

classifying and outputting each of these events into the categories of presentation, links, unity, management, administration, action and command;

denoting each of these categories using keywords.

3a The mehod of 3 , the medical file in medical scripting language comprising events with the implemented steps of :

having each event to comprise the following components of a date/time header, a structured medical terminology descriptor that is humanly readable and defined for the computer interpreter, a comment field, a field for recording the signature of person making the entry or amendment, recordal means for accession details, and a field to denote the status of the event;

the structured medical terminology descriptor may describe a presentation or links or unity or management or administrative data or a command for the supervisory program.

the status of each event is denoted as a neutral log event or global active event or global inactive event or negative event to be archived or culled.

3b. The method of claim 3, the medical scripting language comprises a structured medical language component that is human and computer parseable format and comprising the classification of medical entities such as symptoms , signs, diagnoses, treatment investigations and investigations results - in a linnean hierarchy , each entity has an alphabetic keyword mapping to a computer object which holds the belief system for the said medical entity ;

each medical entity is further classified as either a presentation type for symptom or sign, a link type for investigation result, a unity type for diagnosis, a management type for drug treatment, an administration type for housekeeping and a command type for use in invoking protocols in the supervisory program.

**3c The method of claim 3, comprising means for the patient file to be downloaded in HTML format to be viewed as a web page with a Mosaic type browser.**

**3d The method of claim 3, comprising means for the patient file to be downloaded in ASCII character string format to be viewed as a document by a text editor.**

**3e The method of claim 3, comprising steps for the patient file to have its events aggregated for administrative, command, action, presentation, links, unity and management items sorted in a chronological order.**

**3f The method of claim 3, comprising steps for the structured medical language moeity to be associated with a value using the % operator.**

**3g The method of 3 , the medical file in medical scripting language comprising means to represent a snapshot of the present and past patient medical status, comprising all relevant and significant medical information, comprisng all preventive protocols, comprisng all preventive protocols and the trace of all events arising from these protocols are held in one location as a file or record or virtual record.**

**3h The method of 3, the medical file in medical scripting language comprising steps of aggregating events into not yet defined entities, about to be defined entities, well defined entities and management, providing the basis for medical problem solving utilising the spreadsheeting process.**

**3h The method of 3, the medical scripting language comprises means to do reminders and recall, including the implemented steps of;**

**establishing a framework for recall starting from three ordered Collections of command, action and management;**

**starting from events in this framework the step of recall action is initiated;**

**comprising means for command events to be user defined to extend utility of framework to do non-medical reminder work.**

**3h The method of 3, the medical scripting language comprises means with implemented steps of;**

**have the patient file downloaded to a client in the network stripped off the administrative data or any obvious patient identifier, termed a headerless file, to ensure privacy of medical record;**

**the patient identifier of this headerless file is a dynamic randomly computer generated number sequence known to both client and server, that is relevant only for the duration of the client computer session.**

**4. The medical spreadsheet browser of the patient file written in medical scripting language comprises implemented steps of:**
**requesting patient file written in medical scripting language from a network or internet server;**
**opening and parsing each patient file written in medical scripting language;**
**extracting all commands to be executed embeded in the patient file ;**
**storing all presentation or symptoms or signs events in a data collection and displaying them on a computer pane;**
**storing all links or medical investigations result events in a data collection and displaying them on a computer pane;**
**storing all unity or diagnosis events in a data collection;**
**storing all management or prescription or procedure events in a data collection and displaying them on a computer pane;**
**and develops possible solutions within a framework of an interrelationship among preselected medical data ;**
**and comprising means for scrolling and saving worksheets.**

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